EXPERIMENT 4: newton's second law

PURPOSE:
To understand how the mass/force change the acceleration on an object and to verify Newton's second law: $F = m\,a$

EQUIPMENT:
Long ramp (see experiment 3) with a car(example pasco PAScar ME-6950 or the kit from sargent welsh) and pulley (for example pasco ME-9448B) , string ,mass holder graph paper, stop watches, masses.

My set up: 10g to provide a constant force for part 1. A set of 200g to increase the mass of the car in part I. A set of 20g for part II. The car I used was about 500g. Note: Those numbers will depend on the car you use.

DATE______________

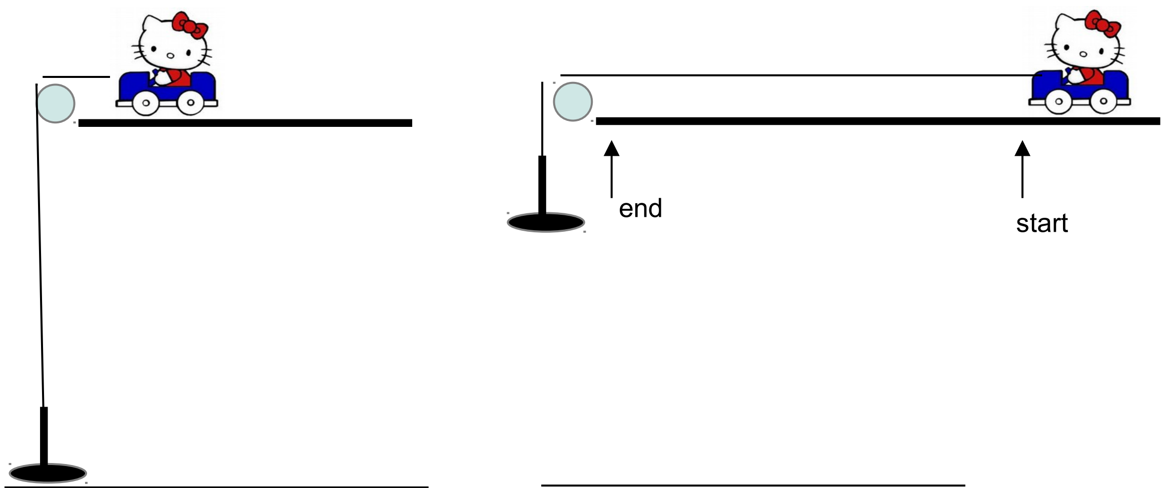
AUTHOR ____

PARTNER _______________________________________

PARTNER _______________________________________

BACKGROUND:

The amount of an object's acceleration depends on the mass of the object and the size of the force acting on the object. In this lab, you will learn what happens to acceleration when mass and force are varied.



PROCEDURE:
MAKE SURE THE CAR DOES NOT GO OVER THE PULLEY.
Someone has to be ready to stop the car from falling. Make sure the ramp is flat.

1. Attach the string to the car and the other end of the string to the mass holder: the string goes through the pulley and when the car is about to bump into the pulley, the mass holder is about to reach the ground.
SEE FIGURE ABOVE.

2. Mark the starting point and the last position with a pencil or post it. (see figure above).
<u>The distance between those two positions is the distance covered by the car</u>

distance = __________________ record this value in the table below.

3. measure the mass of the car. Mass = _____________ g . report this number in the tables below (1 and2). Report this number in the first cell of the tables as well.

PART I: CHANGING THE MASS IN THE CAR (independent variable)

1. Place the car at the starting point. Place 10g on the mass holder (that pulls the car down) . Leave the 10g there during PART I.

2. Use the stopwatch (smartphone) to time how long it takes for the car to cover the distance marked. Record your timing in TABLE 1

3. Repeat this step for 3 more trials and mark the time for each.

4. Add 200 g (black masses) **IN THE CAR** (not on holder) to increase its total mass and repeat steps 2and 3. Leave the 5g as the pulling force.

5. Keep adding 200g to the car until you get to 800g added to the mass of the car.

TABLE 1 Acceleration with different masses in the car

DISTANCE (cm) = __________ mass of the car _____________ (g)

Mass in car in grams	**Trial 1 time(s)**	**Trial 2 (s)**	**Trial 3 (s)**	**Trial 4 (s)**	**Average time (s)**	**Acceleration (cm/s/s)** (wait for analysis to fill this column)
Mass of car=						
Mass of car +200=						
Mass of car+400						
Mass if car + 600=						
Mass if car +800						

PART I: CHANGING THE WEIGHT PULLING THE CART (FORCE) (independent variable)

Leave the additional 800 g in the car. Leave it there for all of PART II.

Remove the 10g from the mass holder (pulling force).

1. Place 20g on the mass holder (pulling mass). . You will keep the mass of the car the same.

MAKE SURE THE CAR DOES NOT GO OVER THE PULLEY.

2. Place the car at the starting point and time how long it takes to cover the distance.

3. Repeat 2 for 3 more trials and record in TABLE 2.

4. . Add 20 g to the mass holder and repeat step 3.

5. Keep adding 20g until the holder has 120g altogether. At this point, you should be very careful the car does not fall. Make sure to be recording the times in TABLE 2.

TABLE 2: Acceleration with different forces
DISTANCE = _________ cm total mass of the car = 800g + mass of the car = _________ g

Force pulling the car grams	**Trial 1 (s)**	**Trial 2**	**Trial 3**	**Trial 4 (s)**	**Average time (s)**	**Acceleration (cm/s/s)** (wait for the analysis part)
20g (mass holder)						
40g						
60g						
80g						
100g						
120g						

ANALYSIS:

1) For each of your measurements in TABLE 1 and TABLE2 , calculate:
- the average time (report in the tables)

- acceleration using the following formula: **acceleration = (2 x distance) / (time^2)**
(from the kinematics equation $x = 1/2 \ a \ t^2$ with x is the position)

2) Make a scatter plot of *acceleration (y-axis) vs mass* (x-axis) for the data in TABLE 1 This is not a line. Don't do a bets fit.

3) Make a scatter plot *acceleration (y-axis) vs force* (x-axis) or the data in TABLE 2. Trace the best fit line. This is graph 2

4) What is the independent variable in the first set of data ? (from TABLE 1 and first graph)

How does the acceleration changes as this variable changes ? (increase? Decrease? Stays the same?)

5) Newton's second law $F = ma$ or $a = F/m$ predicts that the acceleration a is inversely proportional to the mass (m) if we keep the force pulling on the mass the same. So the graph should be similar to $y = 1/x$.
(y is the _________ and x the __________)

Go on line on wolfram alpha webiste . Type:
plot 1/x for x between 0 and 400

Trace below the graph of 1/x as shown by the computer.

Compare this graph to yours. Are they similar ? And why ?

6)What is the independent variable in the second set of data ? (TABLE 2 and graph 2)

How does the acceleration changes as this variable changes?

7) Newton's 2nd law predicts $F = ma$ or $a = F/m$ that is the acceleration is proportional to the pulling force if we keep the mass of the moving object the same. Do you get a line for graph 2 ?
What is the equation?

What is the slope ? (watch unit)

What do you think the slope represent ? (use the mass m)

8) If a mass of 10kg is acted upon by a force 10N the acceleration is __________ m/s/s

CONCLUSION:

Was the purpose of this lab accomplished ? Why or Why not ?

(your answer to this question should show thoughtful analysis and careful, through thinking)